Exploring social determinants of health through small-area mapping of BRFSS variables

Presented to: OPHA Annual Conference

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The social determinants of health (SDH) are the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies and political systems.

http://www.who.int/social_determinants/en/

<table>
<thead>
<tr>
<th>Economic factors</th>
<th>Housing</th>
<th>Transportation</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>Access to care</td>
<td>Community design</td>
<td>Social constructs</td>
</tr>
</tbody>
</table>
## Leveraging BRFSS and Census

<table>
<thead>
<tr>
<th>Behavioral Risk Factors Surveillance System</th>
<th>American Community Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telephone survey conducted by Oregon Health Authority</td>
<td>Paper survey conducted by U.S. Census Bureau</td>
</tr>
<tr>
<td>Publically available data to the county level</td>
<td>Publically available data to the block group level</td>
</tr>
<tr>
<td>• Demographics</td>
<td>• Demographics</td>
</tr>
<tr>
<td>• Chronic disease</td>
<td>• Socioeconomics</td>
</tr>
<tr>
<td>• Health behaviors and status</td>
<td>• Household composition</td>
</tr>
<tr>
<td>• Health care access</td>
<td>• Health insurance</td>
</tr>
</tbody>
</table>
A model for computing small area estimates (SAEs)


Predicting health outcomes

Assumption: The probability of an individual’s health outcome depends on that individual’s

- Age
- Race
- Sex
- County poverty rate
- Other (unknown) county characteristics

Logistic Linear Mixed Effects Model:

\[ P(\text{Outcome}_i) \sim [1 \ Agegroup_i \ Race_i \ Sex_i \ Poverty_i] \cdot \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{bmatrix} + \text{County}_i + \text{Error}_i \]

Agegroup, Race, Sex, and Poverty are fixed effects; County is a random effect
Adapting the model for Oregon BRFSS data

Zhang, et. al. model

- U.S. wide data set
- One year of data BRFSS data
- States and counties included as random effects
- Poverty rates are for whole population
- 2010 Census demographics
- Implemented in SAS using GLIMMIX

Oregon BRFSS model

- Oregon wide data set
- 2 years of data (2014, 2015)
- Counties included as random effects
- Poverty rates exclude ages 18-24
- 2011-2015 ACS demographics
- Implemented in R using glmer
Example 1: Obesity

Data from Oregon 2015 and 2014 BRFSS
Obesity probabilities

- 8 Age Groups
- 8 Race/Ethnicity Categories
- 2 Sex Categories
- 128 distinct probabilities
County demographics

Benton County

Jefferson County

Marion County
Estimating obesity rates

Obesity prob. Matrix

Benton demographics
22%

Jefferson demographics
35%

Marion demographics
31%
## BRFSS Variables

### Chronic disease

<table>
<thead>
<tr>
<th>Condition</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthritis</td>
<td>Heart attack</td>
</tr>
<tr>
<td>Asthma</td>
<td>Heart disease</td>
</tr>
<tr>
<td>Cancer</td>
<td>Stroke</td>
</tr>
<tr>
<td>COPD</td>
<td>High Blood Pressure</td>
</tr>
<tr>
<td>Depression</td>
<td>Obesity</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Overweight or obesity</td>
</tr>
</tbody>
</table>

### Other variables

<table>
<thead>
<tr>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binge drinking</td>
</tr>
<tr>
<td>Smoking</td>
</tr>
<tr>
<td>Diabetes test</td>
</tr>
<tr>
<td>Health insurance coverage</td>
</tr>
<tr>
<td>General health status</td>
</tr>
<tr>
<td>Mental health status</td>
</tr>
<tr>
<td>Physical health status</td>
</tr>
<tr>
<td>Disability status</td>
</tr>
</tbody>
</table>
Model Limitations

- Potential non-representative samples in BRFSS or in ACS data
  - Model misspecification
  - Systematic or sporadic error in small area estimates

- Potential failure of model assumptions
  - Health outcome poorly correlated with independent variables
  - Health outcome correlated with confounding variables

- Large census tracts’ visual prominence doesn’t represent their smaller proportion of the population

- Artificial geographic boundaries

- Only possible stratification is by geography

- Statistics categorize but individuals are unique
Mapping Small Area Estimates

- Cities and towns
- County subdivisions
- Census tracts
- Census block groups
Example 2: Smoking and Tobacco Retail Outlets

Benton County has one of the lowest tobacco use rates in the state

Only 10 percent of Benton County residents smoke cigarettes
City of Corvallis
Predicted smoking prevalence by census tract, Schools, and Tobacco retail outlets

Predicted smoking prevalence
- 6% - 8%
- 9% - 11%
- 12% - 14%
- 15% - 32%

Benton County Schools
Tobacco Retail Outlets
Example 3: Diabetes and access to grocery stores

Seven percent of Benton County residents have been diagnosed with diabetes.

The average Benton County resident lives 2.3 miles from the nearest grocery store.
Diabetes and grocery access
Benton County
2014-2015

Estimated diabetes prevalence
- 0% - 3%
- 4% - 7%
- 8% - 11%
- 12% - 17%

[Map showing diabetes prevalence by area in Benton County, 2014-2015]
Diabetes and grocery access
Benton County
2014-2015

Estimated diabetes prevalence
- 0% - 3%
- 4% - 7%
- 8% - 11%
- 12% - 17%

Each dot represents the approximate location of 10 addresses.
Diabetes and grocery access
Benton County
2014-2015

Estimated diabetes prevalence
- 0% - 3%
- 4% - 7%
- 8% - 11%
- 12% - 17%

Distance in miles to a grocery
- 0.4 - 1.1
- 1.2 - 2.2
- 2.3 - 4.1
- 4.2 - 9.4

Each dot represents the approximate location of 10 addresses.
Contact information

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541-766-6364

Data sources:
U.S. Census Bureau ACS 2011-2015 5-year estimates
Corvallis Tobacco Retail Licensing program
Oregon Environmental Public Health Tracking Tool, 2012